

Infectivity and Persistence of *Steinernema scapterisci* Nematodes on Pasture Mole Crickets in Florida¹

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This is an account of the experience of UF/IFAS personnel and collaborators in the Florida Department of Agriculture and Consumer Services in applying *Steinernema scapterisci* nematodes to Florida pastures against pest mole crickets. The first objective was to find out whether this South American nematode could establish populations in Florida pastures, and whether these populations would spread. The second was to evaluate its effectiveness in controlling populations of pest mole crickets (*Scapteriscus borellii* and *S. vicinus*), and its potential to bring economic relief to livestock producers in most or all of Florida. The third was to demonstrate to ranchers a method of applying the nematode, so that they could do so themselves on their land with purchased nematodes, which could hasten the distribution to all of Florida.

1985-1997, the Entomology/Nematology Department Effort - Part of the UF/IFAS Mole Cricket Research Program

The Florida Legislature in 1978 instructed UF's Institute of Food and Agricultural Sciences (IFAS) to begin a mole cricket research program to provide economic relief to Florida cattle ranchers. The UF/IFAS Mole Cricket Research Program was initiated within the Entomology & Nematology Department, with many entomologists and a few nematologists involved, and a few collaborators in other IFAS departments. One of its actions was to investigate the potential of natural enemies in the South American homelands of Florida's pest mole crickets. A species of steinernematid nematode from Uruguay, one of the natural enemies detected, was studied as a classical biological control agent. Two UF/IFAS nematologists (as part of the UF/IFAS Mole Cricket Research Program) were sent to Uruguay and they carried stock of this nematode to Florida early in 1985. In 1990, after it had been differentiated from all known nematodes, it was

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described as a new species, *Steinernema scapterisci* Nguyen & Smart.

At first, the nematode could be reared only in pest mole cricket hosts, which limited its production. Nevertheless, laboratory production allowed experimental application in small plots in pastures in Alachua County in 1985, 1986, and 1988. The entomologists who conducted the fieldwork under the program showed that the nematode became established, killed pest mole crickets but not native non-pest mole crickets, and began to spread, presumably carried by infected mole crickets. Spread of the nematode was not only by infected mole crickets walking, but also by flight by infected mole crickets, allowing much faster spread. Infected mole crickets turned up in Gainesville, miles away, by 1989. Some of the sites were monitored weekly for five years showing continuing infection of mole crickets by *S. scapterisci* throughout this time.

The use of this nematode for mole cricket control was patented by UF. An advantage (when the patent was granted) was that the UF Office of Technology Licensing could select a licensee to produce and market the nematode, ensuring that the product would be of high quality. This seemed to be the only way to produce the trillions of nematodes necessary for its rapid deployment to all of Florida. Landowners would have to buy the nematodes if they wanted rapid action on their land, because natural spread from established populations in Alachua County could take decades.

Before the patent was issued, the nematologists supplied stock of the nematode to a company called **Biosis** (later renamed **biosys**) of Palo Alto, California. That company developed mass-rearing methods and supplied product in 1989 to the UF/IFAS Mole Cricket Research Program for testing in Florida pastures. In each of six counties (Clay, Flagler, Highlands, Hillsborough, Osceola, and Pasco), pastures were selected by county extension agents for experimental application. In each of these pastures a 1-hectare (2.4-acre) central plot was marked for treatment. Nematodes were applied in the fall by chisel-rig with a 100 gallon tank containing water and the nematodes, at 2 billion per 1-hectare plot. An untreated pasture was also designated in each

county, to be not less than 1-mile distant from the application site. Thirteen pitfall traps were installed in each of the 12 pastures with the objective of trapping mole crickets, recording percent parasitism, and measuring the rate of spread of the nematode after application. Maintenance of the pitfall traps and routine collection of mole crickets was conducted by county extension employees. A centralized contract with UPS allowed weekly shipment of cooler chests with mole crickets to Gainesville, or empty in the return direction, over two years. Mole crickets shipped to Gainesville were all held until they produced, or did not produce, evidence of infection by *S. scapterisci* nematodes.

Results of the 2-year experiment showed that *Ss* populations became established at five of the six application sites. The exception was a pasture in Highlands County, probably because it flooded by heavy rains at the time of application. For the five pastures with successful application, average distance dispersed was 60 meters in 21 months. In Clay County only, nematodes were detected at the untreated control site, perhaps because this was close to a grocery distribution center whose lights at night may have attracted flying infected mole crickets.

The UF Office of Technology Licensing negotiated with a start-up company, Tampa-based **BioControl**, to market the nematode. Nematodes were produced by an offshore, US-owned company and shipped to **BioControl** which marketed them and was willing to apply them when landowners so wished. **BioControl** marketed them under a tradename Proact, later changed to Proactant. So nematodes were applied commercially to additional sites in additional counties of which we have no record.

The UF/IFAS Mole Cricket Research Program, having shown the value of the nematode, seen its commercialization, and with formal publications in preparation (see References) considered that it had done its job with *S. scapterisci* and shifted its research emphasis to other biological control agents that were equally promising. Two of these, a wasp (*Larra bicolor*) and a fly (*Ormia depleta*), had been released and established in Florida in 1988, but research was far from complete.

The offshore producer of the nematode made a business decision to end nematode production. **BioControl**, which had relocated from Tampa to Alachua, struggled to produce its own nematodes, but went out of business by 1996. By the end of 1996, cattle ranchers in southwestern Florida had detected a decline of Bahiagrass, and they attributed this to damage by mole crickets although other causes seemed also to be involved.

In 1997, the UF/IFAS Mole Cricket Research Program was requested (by the Director of the Ona Experiment station) to revisit some of the pastures where *S. scapterisci* applications were made in 1989 and evaluate persistence of *S. scapterisci*. Pitfall traps were installed and operated for months, and mole crickets trapped were examined for the presence of *S. scapterisci*. The four localities visited in Clay, Flagler, Osceola and Pasco counties all showed high levels of infection of mole crickets by the nematode. The nematode had persisted eight years, and its presence was deemed likely to be permanent. In other words, *Ss* serves as a classical biological control agent (like the wasp and the fly) and is not just a biopesticide. But *Steinernema scapterisci* was no longer available for purchase, so could not be applied to the pastures in southwestern Florida where Bahiagrass decline was a problem.

2000, an Agronomy Department Project -- Based at the Range Cattle Research Station, Ona

In the late 1990s, the UF/IFAS Agronomy Department entered the mole cricket fray by hiring an agronomist at the Range Cattle Research Station at Ona, and instructing him to investigate "Bahiagrass decline." He soon decided that he should investigate control of pest mole crickets, and was provided with funding.

The big question was whether commercial production of *S. scapterisci* could be restored, to make it once again available to ranchers. The expected high purchase price of the nematode led to discussion (with remaining UF/IFAS Mole Cricket Project members) of application only to hot-spots of mole cricket activity or in strips across pastures. It was known that the nematode could spread, so such

tactics should reduce cost per acre. There was interest in detecting any difference in outcome between fall and spring applications.

In 2000, an offshore nematode producer was persuaded to produce a batch of *S. scapterisci* nematodes. In September 2000, nematodes were applied in strips to distribute 1/8, 1/4, and 1/2 billion nematodes/acre on a 24-acre Bahiagrass pasture near Polk City. A specially modified seed-drill (slit injector) was used for the applications. Some plots in that pasture did not receive nematodes. Each treatment was replicated three times. This experiment was done to determine the rate of nematode spread within mole cricket populations on pasture at reduced nematode application rates. Six pitfall traps were installed on each plot and the numbers of mole crickets trapped were recorded weekly. Samples of trapped mole crickets were analyzed monthly for nematode infection.

Mole crickets are very mobile, and infected mole crickets spread the nematodes throughout that pasture within a few months. In the fall of 2001, the entire pasture was flooded for several days and adult mole crickets relocated. Results show that the nematodes persisted through the fall and subsequent winter months and resumed breeding in adult mole crickets during the spring of 2002. Then, the mean nematode infection in mole cricket population on that pasture was 34% regardless of initial nematode application rate. Mole cricket numbers declined by 65-80% and pasture grass ground cover in the spring of 2002 was 58-100%, representing a 45 to 200% increase relative to grass cover estimated in 2000.

2001-2002, A Brief State Mole Cricket Program

To promote widespread distribution of mole-cricket-killing nematodes in Florida, a task force of interested parties included personnel of UF/IFAS, of the Florida Department of Agriculture and Consumer Services, Department of Plant Industry (FDACS-DPI), allied industrialists, and producer organizations such as the Florida Cattlemen's Association and Florida Turfgrass Association, and the few remaining elements of the old UF/IFAS Mole Cricket Research Program was

established in 2000. The enlarged task force, under leadership of Norman Leppla (UF/IFAS IPM Coordinator), successfully recruited MicroBio (UK), a subsidiary of Becker Underwood (USA) as the sole commercial producer and distributor of the mole cricket nematode (*Steinernema scapterisci*) with contract negotiated by the UF Office of Technology Licensing. MicroBio named its nematode product Nematac® S. The Florida Legislature provided the task force, through FDACS-DPI, with \$300,000 in 2001 “to reestablish a Mole Cricket State Program.” The purpose of those funds was to support research/demonstration activities on biological control of mole crickets and conduct area-wide testing of the nematodes in Florida. The cost of the program from 1978-2000 exceeded \$1.5 million.

For the first phase of the State Program, Nematac S donated by MicroBio was applied in spring 2001 at seven ranches in Hardee (3), DeSoto (1), Pasco (2), and Polk (1) counties. Sites had no pre-application history of *S. scapterisci* based on examination of trapped mole crickets. Nematodes were applied with the slit-injector machine in strips at the 1/4 and 1/8 billion rates. Applications were announced in advance and served as field days. Few adult mole crickets were trapped at these sites in fall 2001. In spring 2002, no differences between the effects of 1/8 and 1/4 billion rates of nematode application on infection level were observed. All sites produced evidence of infected mole crickets.

The second phase of the State Mole Cricket Program on pasture involved nematode application to pasture and sod farms on 13 sites in south-central Florida in fall 2001. Nine ranches in DeSoto (1), Hardee (1), Highlands (1), Manatee (2), Orange (2), Osceola (1), and Pasco (1) counties received applications of Nematac S applied with the slit-injector in strips at 1/8 billion nematodes/acre. At Hollingsworth ranch in DeSoto Co., one out of the five pre-application mole crickets trapped was infected with the nematode. This was probably due to previous nematode application to turfgrass in the area in the 1990s. No other site had a pre-application history of nematodes. Additionally, Nematac S was applied on sod farms in DeSoto (1), Manatee (1), Osceola (1), and Polk (1) counties. The slit injector was used at the Polk County farm, but spray rigs were

used at the others followed by irrigation. All sites except at one ranch in Orange County later produced evidence of nematode-infected mole crickets.

These studies showed that applications were generally successful, regardless of whether application was made in spring or fall. Nematodes persisted through flood and cold winter months. There was dramatic recovery of pastures in most cases.

Applications in the Florida Panhandle

Experimental applications of *Steinernema scapterisci* were then made in several counties in the Florida panhandle by Richard Sprenkel and Ann Blount (North Florida Research and Education Center), but evidence of establishment of populations is not yet available.

Aftermath

S. scapterisci nematodes became commercially available again to ranchers and sod growers in spring 2002. Marketing information may be obtained from Becker Underwood (1-800-232-5907) which uses its trade name, Nematac S, for the nematode.

Counties in which at least one pasture has been treated successfully with *Steinernema scapterisci* (with earliest date of application) now include Alachua (1985), Clay, Flagler, Hillsborough, Osceola, Pasco (1989), Polk (2000), DeSoto, Hardee, Highlands, Manatee, and Orange (2001). We know the nematode has spread from the Alachua and Clay County sites, and it should be doing the same from all the others.

The UF/IFAS Mole Cricket Research Program is no longer a formal project. It ended in fall 2004 after 25 years of research. Its accomplishments are described in a four-page article in the IFAS **Impact** magazine in spring 2005. Its website is <http://MoleCrickets.ifas.ufl.edu>

A few UF/IFAS faculty members with FDACS-DPI collaborators are carrying on its tradition and concentrating their efforts on the other biological control agents, especially the beneficial wasp *Larrea bicolor*, to make statewide mole cricket control a reality.

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